



Acceleration Measurements Aboard The International Space Station

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Overview

Providing a quiescent microgravity, or low-gravity, environment for fundamental scientific research is one of the major goals of the International Space Station program. This apparent weightlessness is created as the Space Station circles and falls around the Earth, and the continuous free fall simulates the absence of gravity.

However, tiny disturbances aboard the space station mimic the effects of gravity, and scientists need to understand, track and measure these potential disruptions. Two accelerometer systems developed by NASA's Glenn Research Center in Cleveland, Ohio, are being used aboard the Station. Operation of these systems began with Expedition Two and will continue throughout the life of the Space Station. NASA fuels discoveries that make the world smarter, healthier and safer.

The Space Acceleration Measurement System II (SAMS-II) measures accelerations caused by vehicle, crew and equipment disturbances. These vibratory/transient accelerations occur in the frequency range 0.01 to 300 Hertz. To complement the SAMS-II measurements, the Microgravity Acceleration Measurement System (MAMS) records accelerations caused by the aerodynamic drag created as the Space Station moves through space. It also measures accelerations created as the

vehicle rotates and vents water. These small, quasi-steady accelerations occur in the frequency range below 1 Hertz.

Using data from both accelerometer systems, the Principal Investigator Microgravity Services (PIMS) project at the Glenn Research Center helps investigators characterize accelerations that influence their Space Station experiments. The acceleration data is available to researchers during the mission via the World Wide Web. It is updated nominally every two minutes as new data are transmitted from the Station to Glenn's Telescience Support Center. A catalog of acceleration sources also is maintained.

SAMS

Experiment Name: Space Acceleration Measurement System II (SAMS-II)

Missions: ISS Flight 6A, STS-100 Space Shuttle Flight, Expedition Two and following

Experiment Location on ISS: Multiple locations throughout the U.S. Laboratory Module, Destiny

Project Manager: William M. Foster, NASA Glenn Research Center

SAMS-II began operations on ISS Mission 6A when it arrived at the Space Station, and scientists at the telescience center at Glenn Research Center sent a command to turn the experiment on. SAMS-II measures vibrations that affect experiments

located near the cause of the vibration. For example, if a piece of equipment is vibrating, it may disturb the experiment next to it. Therefore, SAMS-II uses small remote triaxial sensor systems that are placed directly next to experiments in various locations throughout the laboratory module. For Expedition Two, there will be five sensors located in the EXPedite the PROcessing of Experiments to the Space Station Racks (EXPRESS) with experiments before launch.

As the sensors measure accelerations electronically, they transmit the measurements to the Interim Control Unit (ICU) located in an EXPRESS Rack drawer. Data is collected from all the sensors and downlinked to Glenn Research Center's Telescience Support Center where it is processed and displayed on the Principal Investigator Microgravity Services Space Station Web site to be viewed by investigators. The Interim Control Unit can record acceleration data from all the sensors and save it for later transmission to the ground control center.

SAMS-II is designed to record accelerations for the lifetime of the Space Station. As larger, facility-size experiments fill entire Space Station racks in the future, the Interim Control Unit will be replaced with a more sophisticated computer control unit. It will allow onboard data analysis and direct dissemination of data to the investigators' telescience centers located at university laboratories and other locations around the world.

Special sensors are being designed to support future experiments that will be mounted on the exterior of the Space Station. These experiments include NASA's Low Temperature Microgravity Physics Facility to be located on the Japanese Experiment Module-Exposed Facility.

MAMS

Experiment Name: Microgravity Acceleration Measurement System (MAMS)

Missions: ISS Flight 6A, STS-100 Space Shuttle Flight, Expedition Two and following

Experiment Location on ISS: U.S. Laboratory Module, Destiny, EXPRESS Rack No.1

Project Manager: William Foster, NASA Glenn Research Center

MAMS measures accelerations that affect the entire Space Station, including experiments inside the laboratory. It fits in a double middeck locker, in the U.S. Laboratory Module in EXPRESS Rack No.1. It was preinstalled in the rack, which was placed inside the Space Station laboratory during Expedition Two, Space Station Flight 6A.

The MAMS accelerometer sensor is a spare flight sensor from the Orbital Acceleration Research Experiment (OARE) program that characterizes similar accelerations aboard the Space Shuttle. Unlike SAMS-II, MAMS measures more subtle accelerations that only affect certain types of experiments, such as crystal growth.



MAMS is installed just above SAMS II in this close-up photo.

Therefore MAMS does not have to be on all the time. During early expeditions, MAMS requires a minimum operational period of 48 or 96 hours to characterize the performance of the sensors and collect baseline data. During later increments, MAMS can be activated for time periods sufficient to satisfy payload or Space Station requirements for acceleration data.

MAMS, which operates automatically and requires no crew activity, is commanded on and off from the Telescience Support Center at Glenn. MAMS is activated when the crew switches on the power switch for the EXPRESS Rack No. 1, and the MAMS computer is powered up from the ground control center. When MAMS is powered on, data is sent to Glenn Research Center's Telescience Support Center where it is processed and displayed on the Principal Investigator Microgravity Services Space Station Web site to be viewed by investigators.

Flight History/Background

The Space Acceleration Measurement System (SAMS)—on which SAMS-II is based—first flew in June 1991 and has flown on nearly every major microgravity science mission on the Space Shuttle. In addition, SAMS was used for four years aboard the Russian space station Mir where it collected data to support science experiments.

MAMS builds on data and procedures developed by the OARE, which has operated during 12 Shuttle missions.

Benefits

Many experiments that require the Space Station's low-gravity environment benefit people on Earth because researchers are learning about processes that gravity masks. Researchers may be able to use what they learn in a reduced gravity environment to improve materials used in automobiles, aircraft and other products. To interpret the data from their experiments accurately, it is of utmost importance to know the exact experimental conditions. What was the temperature? The humidity? And in space, they must know what forces mimic gravity and disturb experiments.

Every experiment on the Space Station benefits from the acceleration data that NASA collects. The Space Station is a new laboratory with new equipment and operating conditions. Assembling and maintaining the Station may result in accelerations never experienced on the Space Shuttle.

There will be many more experiments and types of equipment on the Station than on the Shuttle, so it will be even more important to measure vibrations and accelerations that disturb experiments. This information will be useful to hardware developers designing equipment to operate with as little vibration as possible as well as to Station planners scheduling experiments when accelerations are minimal.

Another activity measures accelerations during Shuttle dockings with the Station and when the Shuttle boosts the Station to keep it in the proper orbit. These measurements began during Expedition Two, starting with Space Station Flight 7A, Shuttle flight STS-104, the mission that immediately followed delivery of the accelerometers to the Station.

More Information on this experiment and other experiments is available at [http:// www.nasa.gov](http://www.nasa.gov).

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